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Ultrasonographic Visualisation of Anatomical Variation of the Medial Cutaneous Nerve of Forearm and its Depiction by the Novel Use of a Custom Computer Program to generate 2D Diagrams

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Keywords: ultrasonography, medial cutaneous nerve of the forearm, medial epicondyle, anatomical models

All abbreviations with their definitions:

MCNF - medial cutaneous nerve of the forearm

USG - ultrasonography

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IEL – inter epicondylar line

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Ultrasonographic Visualisation of Anatomical Variation of the Medial Cutaneous Nerve of Forearm and its Depiction by the Novel Use of a Custom Computer Program to generate 2D Diagrams

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Cutaneous nerves display significant anatomical variation, and are therefore vulnerable to iatrogenic injury during various surgical procedures. [1-3] High-resolution ultrasonography (USG) was used in this study to investigate this variation, and map the course of the medial cutaneous nerve of the forearm (MCNF). We also aimed to develop a method to virtually represent this variation, which could be used to plan procedures involving the MCNF.

Methodology:

Ethical approval was obtained from the Human Biology Research Ethics Committee, University of Cambridge (HBREC.2019.27). A total of 18 volunteers were recruited and consented to scanning of both upper limbs (n=36 arms). Volunteers were positioned supine, with the upper limb to be scanned abducted and externally rotated. Defined axes were drawn using anatomical landmarks, which served as reference points for USG mapping of the MCNF at 2cm intervals (Figure 1). A preliminary scan with a 12MHz probe was performed to locate the MCNF in the midarm, which was identified by its relation to the basilic vein and by its distribution around the medial epicondyle (ME), and then traced towards the axilla. With the MCNF centred on the monitor, mapping proceeded along the x-axis from 16cm proximal to 12cm distal to the ME. Smaller branches were traced using a 22MHz probe. The perpendicular distance between the x-axis and centre of the probe was measured, serving as the y-coordinate. MCNF coordinates, and sites where the nerve branched or crossed the x-axis were input into a custom Python 3.3 program, which generated Microsoft Excel line charts representing the MCNF.

Results:

The MCNF, its anterior and posterior divisions, and subsequent branches were identified and traced in both upper limbs of all 18 volunteers, generating 36 markedly different anatomical models (Figure 2). From these models, we determined the number of MCNF branches crossing the interepicondylar line (IEL), and the number of branches from the anterior and posterior divisions (Table 1). We found 2 and 3 branches of the MCNF crossing the IEL in the majority of our specimens (52.7% and 38.8%, respectively).

Discussion:

Mapping of any cutaneous nerve is challenging due to the lack of anatomical landmarks for referencing. [4] Hence, drawing of defined axes using identifiable landmarks is important prior to scanning. Not only do 2D diagrams precisely depict the anatomy of cutaneous nerves, they also allow for further data analysis as a large amount of information including the course, branching locations, and crossing points is preserved, which may be lost when select parameters are directly recorded.

In this study, the MCNF bifurcated at a mean distance of 8.0cm±3.4cm (mean±SD) above the IEL, with the large standard deviation (SD) reflecting the variability of this point. Hence, prior to anaesthetic blockade of the MCNF, it is important to trace the nerve both proximally and distally, to be certain that one is blocking the main trunk rather than one of its divisions.

The average number of branches from the two divisions that we identified was significantly fewer than previously reported, [5, 6] which could be due to non-detection of smaller branches by USG. Regarding the number of branches crossing the IEL, our results are comparable with findings from anatomical dissection, [1] demonstrating the validity of USG as a tool for identifying and mapping the course of cutaneous nerves.

To conclude, we recommend USG scanning of the MCNF to clearly delineate its course and branching locations, prior to medial elbow surgery and nerve blockade. We have also developed a novel method to map the MCNF by generating 2D computer models. This can be used as an effective and precise way of investigating anatomical variation in other cutaneous nerves.

Acknowledgements

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Tables:

Table – 1: Data derived from the anatomical models showing the average number of branches from the anterior and posterior divisions of the MCNF

Division of the MCNF	Number of branches	Number of arms (Total = 36)
Anterior division	0	8 (22.2%)
	1	2 (5.5%)
	2	13 (36.1%)
	3	10 (27.7%)
	4	3 (8.3%)
Posterior division	0	18 (50%)
	1	4 (11.1%)
	2	10 (27.7%)
	3	4 (11.1%)
	4	-

Figure Legends:

Figure 1:

Image of an externally rotated, abducted, and extended right upper limb with axes drawn for ultrasound scanning. The X and Y-axis were constructed using three anatomical landmarks: the ME, LE, and US process. The y-axis was drawn by connecting the ME and LE. The x-axis was drawn by connecting the US process with the ME in the forearm, and then continued perpendicular to the y-axis in the arm. Both these axes met at the ME, the '0 point' for measurement of coordinates.

(ME – medial epicondyle, LE – lateral epicondyle, US – ulnar styloid)

Figure 2:

Multiple '2D diagrams' showing considerable variability in the course and branching pattern of the MCNF (8 anatomical models in total; 4 of each side).

(MCNF – medial cutaneous nerve of the forearm, IEL – inter epicondylar line)

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Contributorship statement

Planning	1st author	2nd author	3rd author	4th author	5th author	6th author
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Analysis and interpretation of data	Yes	Yes	Yes	Yes	Yes	Yes
Preparation of manuscript	Yes	Yes	No	No	No	Yes
Review of literature	Yes	Yes	No	Yes	Yes	No
Final draft preparation	Yes	Yes	Yes	Yes	Yes	Yes
Approval	Yes	Yes	Yes	Yes	Yes	Yes

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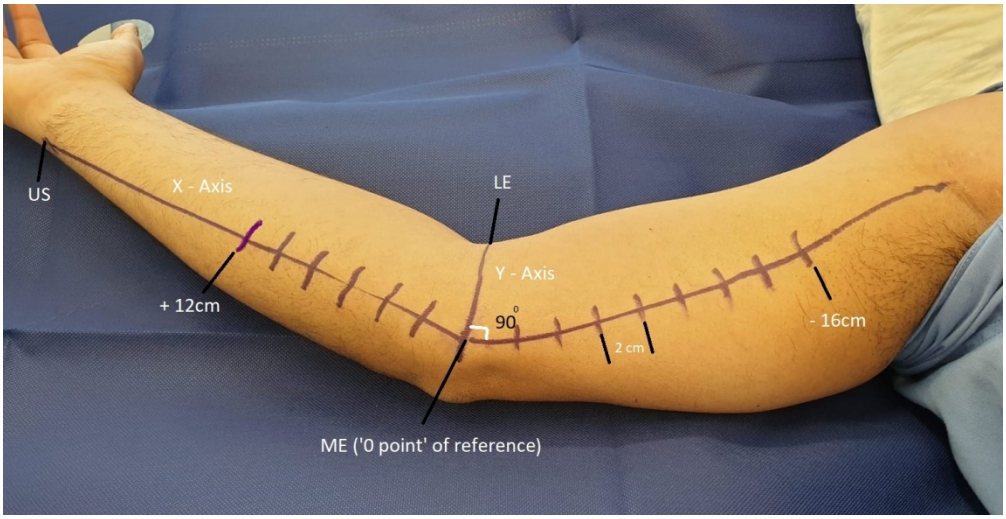

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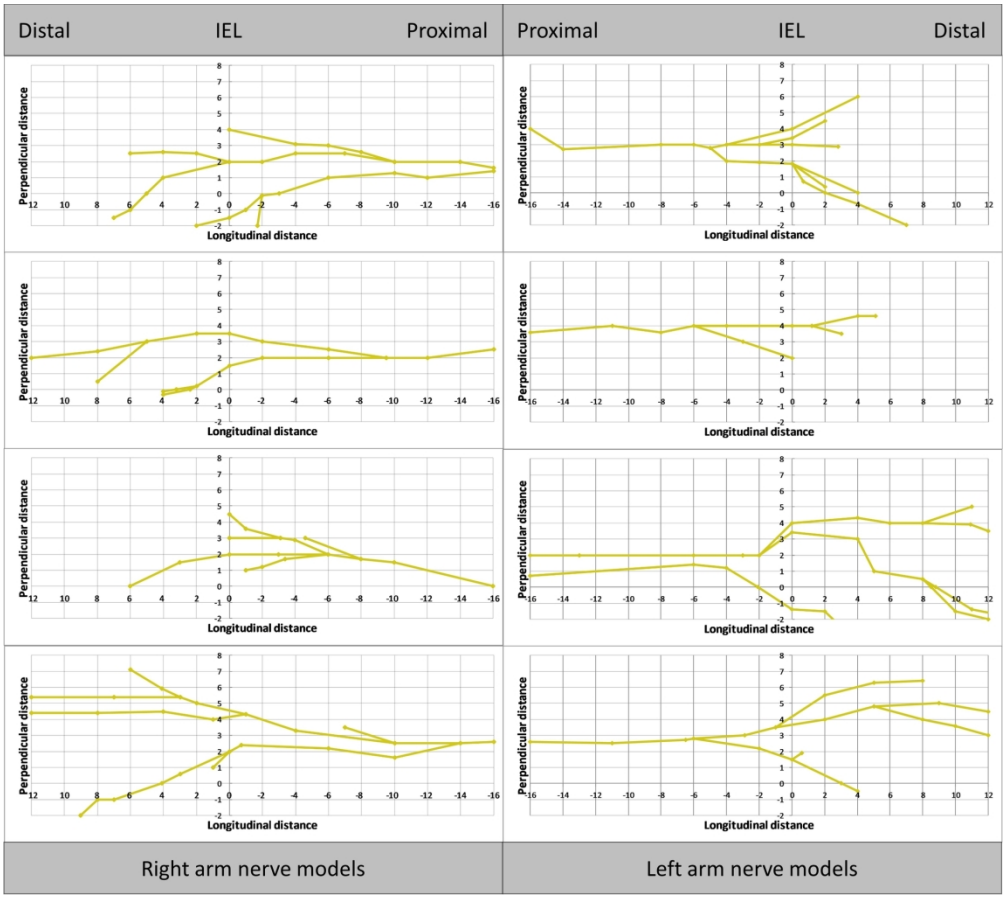

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182x162mm (300 x 300 DPI)